

The University of Chicago

FERTILITY RATES AND MIGRATION OF
KENTUCKY POPULATION, 1920 TO 1940,
AS RELATED TO COMMUNICATION,
INCOME AND EDUCATION

A DISSERTATION SUBMITTED TO THE FACULTY OF
THE DIVISION OF SOCIAL SCIENCES IN CANDIDACY
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF SOCIOLOGY

1943

By
MERTON D. OYLER

Reprint of

KENTUCKY AGRICULTURAL EXPERIMENT STATION BULLETIN 469, November, 1944

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Fertility Rates and Migration of Kentucky Population, 1920 to 1940, as Related to Communication, Income, and Education

BY MERTON D. OYLER

RAPID NATURAL INCREASE of rural population in Kentucky has led to large streams of migration both within the state and to other states. Trends in fertility of population and in migration have much to do with the shaping of economic and social questions and affect many decisions of persons and institutions. They are important especially in relation to public programs affecting economic opportunity, communication, education, and social welfare.

This study was undertaken for the special purpose of investigating the relationships existing as of 1940, in Kentucky, between rural population fertility, rural migration, farm income, the availability of communication facilities, and school attendance. Data were taken mainly from U. S. Census reports, and some important facts were supplied by the Highway Planning Survey of the Kentucky Department of Highways.

METHOD OF STUDY

The method of analysis involved, first, the construction of indexes measuring population fertility, migration, income, communication, and education; and next, analysis of the correlations among these indexes for the 120 counties in Kentucky.

The Measure of Population Fertility

The measure of population fertility selected for this study is the ratio of children under 5 per 1,000 women 15 to 44 years of age.¹ The number of children under 5 was adjusted for underenumeration according to Census Bureau estimates for the East South Central states; the reported number of white children being increased by 7 percent and of negro children by 13 percent. For population groups that included both races, the adjustment was in proportion to the number of children under 5 in each race.

The fertility ratio was adjusted to a standard age distribution of women—that of the "Kentucky White Female Life Table, 1929-1931."² This answered the question: What would the fertility ratio have been if migration had not reduced or increased the influence of certain specific age groups? The importance of this standardization is shown by the age structure of two contrasting counties, Jefferson and Leslie (Fig. 1).

¹For the fertility ratio for the rural-farm population in each county, see Table 2. Inter-county differences are shown graphically in Fig. 8, page 17.

²*Population Statistics, 2: State Data.* U. S. National Resources Committee. 1938.

TABLE 1.—INDEXES OF INCOME AND COMMUNICATION, HIGH SCHOOL RATIO, AND RURAL-FARM NET MIGRATION FROM POPULATION AGED 15-19 YEARS IN 1930, BY COUNTIES^a

County	Income index (1940)	Com-muni-cation index (1940)	High school ratio (1937-38)	Net migration (1930-40)	County	Income index (1940)	Com-muni-cation index (1940)	High school ratio (1937-38)	Net migration (1930-40)
Adair	50	42	14	-19	Knox	32	39	24	-32
Allen	52	51	14	-28	Larue	65	59	9	-31
Anderson	68	73	18	-19	Laurel	40	43	15	-36
Ballard	68	64	25	-28	Lawrence	40	32	16	-46
Barren ^b	63	58	20	-28	Lee	34	37	13	-38
Bath	67	57	12	-30	Leslie	36	20	7	-21
Bell	40	48	24	-50	Letcher	37	48	16	-28
Boone	74	74	25	-22	Lewis	55	43	12	-34
Bourbon	93	85	48	-22	Lincoln	57	59	28	-39
Boyd	53	73	42	-52	Livingston	56	45	22	-34
Boyle	70	79	48	-31	Logan	64	56	21	-24
Bracken	77	73	22	-32	Lyon	59	40	16	-29
Breathitt	33	25	6	-28	McCracken	54	81	55	-45
Breckinridge	58	37	16	-32	McCreary	38	42	12	-26
Bullitt	62	64	22	-29	McLean	66	52	40	-28
Butler	43	27	10	-33	Madison	69	65	22	-38
Caldwell	55	47	28	-32	Magoffin	28	28	7	-38
Calloway	60	60	36	-36	Marion	64	67	18	-30
Campbell	62	87	57	-42	Marshall	51	55	21	-44
Carlisle	63	49	23	-24	Martin	23	31	11	-31
Carroll ^c	78	72	39	-27	Mason	87	79	38	-25
Carter	39	38	19	-36	Meade	60	56	17	-45
Casey	48	39	6	-28	Menifee	36	32	8	-40
Christian	68	59	22	-25	Mercer	76	78	37	-28
Clark	80	80	30	-22	Metcalfe	62	43	13	-19
Clay	35	30	6	-32	Monroe	52	39	12	-31
Clinton	37	35	11	-24	Montgomery	74	71	18	-41
Crittenden	52	42	18	-33	Morgan	39	28	13	-32
Cumberland	47	33	9	-27	Muhlenberg	42	46	27	-40
Daviess	67	67	39	-42	Nelson ^c	73	70	17	-32
Edmonson	46	44	12	-47	Nicholas	75	70	31	-29
Elliott	38	23	8	-29	Ohio	48	39	30	-30
Estill	38	42	14	-40	Oldham	80	76	23	-16
Fayette	91	90	51	-12	Owen	79	65	22	-26
Fleming	71	57	15	-34	Owsley	39	25	9	-26
Floyd	33	43	15	-28	Pendleton	76	73	58	-34
Franklin	76	79	34	-38	Perry	39	45	20	-19
Fulton	79	66	20	-23	Pike	36	48	12	-32
Gallatin	76	66	17	-35	Powell	33	42	10	-30
Garrard	74	68	29	-32	Pulaski	44	47	16	-39
Grant	75	71	40	-34	Robertson	78	66	22	-24
Graves	60	65	33	-34	Rockcastle	42	36	10	-42
Grayson	46	39	18	-41	Rowan	35	43	15	-49
Green	58	48	11	-25	Russell	45	37	15	-26
Greenup	41	48	22	-50	Scott	89	82	30	-26
Hancock	56	48	27	-27	Shelby	88	81	63	-30
Hardin	59	63	30	-36	Simpson	76	71	22	-32
Harlan	40	59	22	+29	Spencer	78	66	14	-19
Harrison	81	74	51	-32	Taylor	62	57	15	-32
Hart	64	52	16	-26	Todd	64	55	20	-32
Henderson	76	68	43	-39	Trigg	63	46	16	-29
Henry	85	69	31	-34	Trimble	75	62	32	-26
Hickman	71	51	29	-27	Union	77	61	30	-39
Hopkins	53	55	36	-37	Warren	67	67	32	-34
Jackson	42	33	10	-17	Washington	73	67	19	-33
Jefferson	59	92	60	-18	Wayne	44	37	12	-36
Jessamine	83	79	23	-21	Webster	59	51	51	-45
Johnson	37	43	18	-36	Whitley	29	47	24	-36
Kenton	61	86	53	-30	Wolfe	27	34	00	-31
Knott	32	31	12	-26	Woodford ^c	97	83	20	-31

^a The other index (fertility ratio) for each county is shown in Table 2.^b Counties indicated by italics contained some urban population in 1930.^c Counties with urban population in 1940, but none in 1930.

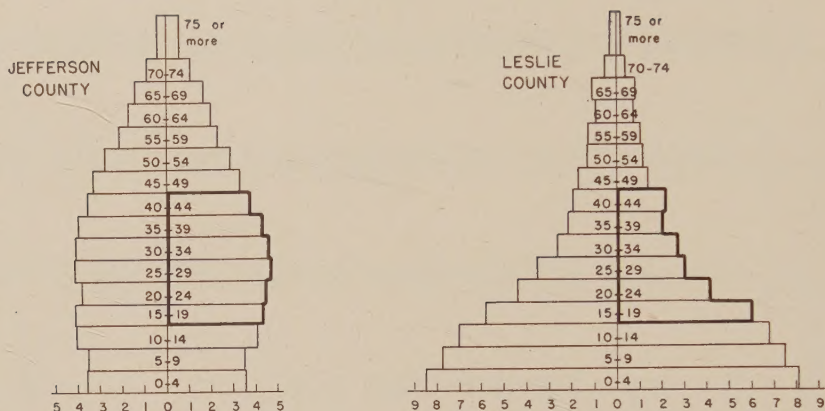


Fig. 1.— Population pyramids for two contrasting Kentucky counties, 1940

Specific birth rates in 1939 per thousand women in Kentucky were.¹

Age of Women	Birth Rate
15 - 19	71.9
20 - 24	151.4
25 - 29	127.0
30 - 34	91.6
35 - 39	64.3
40 - 44	25.7

It is evident that migration of women aged 20-24 from Leslie county, for example, could reduce the crude birth rate in that county very significantly. Similarly, movement of women aged 20-24 into Jefferson county could increase its crude birth rate. Yet there would have been no change in specific birth rates for these counties. Adjustment of the fertility ratio to a standard age distribution was necessary, therefore, in order that differences in population fertility due to factors other than migration might be discerned.

In standardization, the specific ratios of children to women in the standard population were applied to the age distribution of women in the population to be studied. The result was a fertility ratio that would have prevailed in the standard population if its age distribution were exactly like that of the population to be studied. The ratio thus computed, divided by the original fertility ratio of the standard population gave a factor which was then applied to the crude fertility ratio of the population under study.²

¹ See Appendix A, page 29, for discussion of birth rates in relation to ages of women.

² This is the indirect method of standardization, as used by other students of population, notably: G. V. Yule and M. G. Kendall, *An Introduction to the Theory of Statistics*, London, Charles Griffin & Company, Ltd., 1937; David V. Glass, *Population Policies and Movements in Europe*, Oxford, Clarendon Press, 1940; Bernard D. Karpinos, "The Differential True Rates of Growth of the White Population in the United States, and Their Probable Effects on the General Growth of the Population," *American Journal of Sociology*, September, 1938, pp. 259-260. Yule applied this method to death rates, the latter two to birth rates. See Appendix B, page 31, for discussion of the rural-farm population fertility ratio as a logarithmic distribution.

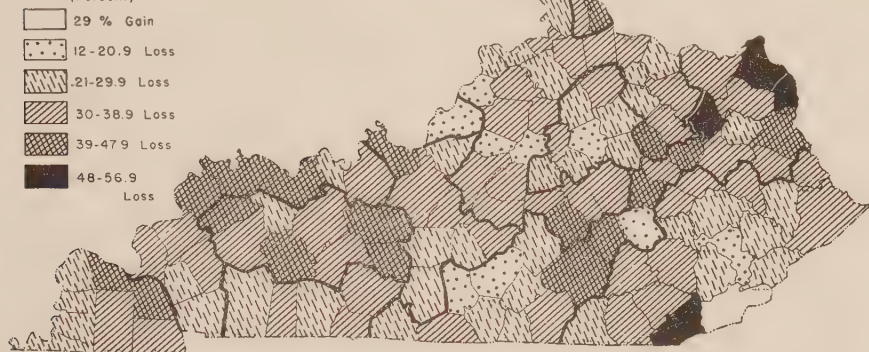
NET MIGRATION, 1930-1940
(Percent)

Fig. 2.— Net migration, 1930 to 1940, of rural-farm population 15-19 years of age in 1930

The Measure of Net Migration

The general procedure for computing net migration estimates by residence classes and by specific age-groups for each county was based on the use of survival rates computed from the life table for the state, using the average of male and female death rates.¹ For example, survival rates show that 97 percent of all persons 10-14 in 1930 would be living in 1940. But the 1940 Census reported only 86.6 percent as many persons 20-24 in 1940 as there had been aged 10-14 in 1930. The difference between the 97 percent who survived and the 86.6 percent who remained, or 10.4 percent, is estimated to be the net out-migration from that age-group.² This procedure was repeated for each other age-group.³

The Measure of Communication Facilities

An index of communication was constructed by combining data for seven separate variables, as follows:

Variable

1. Average daily traffic miles¹ for county and state roads, 1938.
2. All-weather road mileage as a percentage of total mileage, 1940 (All-weather = total less dirt mileage).

Source of Data

Tabulation from traffic surveys;
Kentucky Highway Planning Survey,
State Department of Highways.

Tabulation in manuscript;
Kentucky Highway Planning Survey,
State Department of Highways.

¹ A table of 10-year survival rates for specific 5-year age-groups was prepared from the averages of the two Kentucky white (male and female) life tables for the years 1929-1931.

² Some error was introduced by the application of state survival rates for county data, but it is known to be less than two percentage points (2 percent of the 1930 population age-group) for each specific 5-year age-group that was under 44 in 1930. For the farm population the error for the age-group 15-19 in 1930 was less than 7 percent of the estimated net migration.

³ For net migration, ages 10-19, from counties, see Table 1, page 4.

Variable (continued)

Source of Data

- | | |
|---|---|
| 3. Percentage of farms on all-weather roads, 1940. | Computed from data in <i>Census of Agriculture, 1940.</i> |
| 4. Percentage of farms reporting automobiles, 1940. | Computed from data in <i>Census of Agriculture, 1940.</i> |
| 5. Percentage of farms reporting ¹ electricity, 1940. | Computed from data in <i>Census of Agriculture, 1940.</i> |
| 6. Percentage of total occupied dwelling units reporting radios, 1940. | Computed from data in the <i>Census of Housing, 1940.</i> |
| 7. Circulation of 12 national ¹ magazines in 1937 per 100 occupied dwelling units, 1940. | <i>Consumer's Market Data Handbook, 1939; U. S. Department of Commerce.</i> |

¹ In logarithmic series. See Appendix C, page 32, for report of procedure followed in constructing the index and Appendix E, page 36, for discussion of a communication index for 1930.

Each of the seven variables was highly correlated with every other component of the index (Table 3). The index as finally constructed revealed a wide range of differences in communication facilities among the counties of the state (Fig. 3).

TABLE 3.—INTERCORRELATIONS OF VARIABLES COMBINED IN THE COMMUNICATION INDEX, 1940

Variable	Coefficient of correlation (r) with specified variable					
	Magazines	Radio	Farms electrified	Farm autos	Farms on all-weather roads	All-weather mileage
1. Traffic flow	.689	.693	.703	.582	.635	.681
2. All-weather road mileage.....	.625	.781	.734	.859	.931	—
3. Farms on all-weather roads.....	.671	.765	.725	.921	—	—
4. Farm automobiles	.627	.795	.700	—	—	—
5. Farms electrified	.671	.786	—	—	—	—
6. Radio in homes	.766	—	—	—	—	—
7. Magazine circulation	—	—	—	—	—	—

COMMUNICATION INDEX, 1940



Fig. 3.—Communication index, 1940

The Measure of Farm Income

An index of farm income was constructed by combining data for eight separate variables, as follows:

<i>Variable</i>	<i>Source of Data</i>
1. Income per farm, 1939. ¹ (Value of farm products sold, traded or used, per 100 farms).	<i>Census of Agriculture, 1940.</i>
2. Ratio of total to used products: 1939 ¹	<i>Census of Agriculture, 1940.</i>
3. Income per worker; 1939 ¹ (Value of farm products per 100 agricultural workers 14 years old and over).	<i>Census of Agriculture, 1940.</i> <i>Census of Population, 1940.</i>
4. Gainful workers per unpaid worker ¹ (Total workers 14 years old and over engaged in agriculture per unpaid family worker, 1940).	<i>Census of Population, 1940.</i>
5. Farms per self-sufficing farm, 1939 ¹	<i>Census of Agriculture, 1940.</i>
6. Percentage of incomes \$250+ (Percentage of farms reporting products valued at \$250 and more, 1939).	<i>Census of Agriculture, 1940.</i>
7. Percentage of incomes \$400+ (Percentage of farms reporting products valued at \$400 and more, 1939).	<i>Census of Agriculture, 1940.</i>

¹In logarithmic series. See Appendix C, page 32, for report of procedure followed in constructing the index, and Appendix E, page 36, also for discussion of an income index for 1930.

Each of the seven variables was highly correlated with every other component of the index (Table 4). The index as finally constructed revealed a wide range of difference in farm income among the counties of the state (Fig. 4).

INDEX OF INCOME, 1940



Fig. 4— Index of income, 1940

TABLE 4.—INTERCORRELATION OF VARIABLES COMBINED IN THE
INCOME INDEX, 1940

Variable	Coefficient of correlation (r) with specified variables					
	Percent of incomes \$400+	Percent of incomes \$250+	Farms per self- sufficing farm	Gainful workers per unpaid worker	Income per worker	Ratio of total to used products
1. Income per farm	.932	.878	.855	.842	.924	.934
2. Ratio of total to used products	.869	.793	.861	.845	.852	—
3. Income per worker	.889	.859	.824	.824	—	—
4. Gainful workers per unpaid worker	.884	.825	.859	—	—	—
5. Farms per self-sufficing farm	.915	.828	—	—	—	—
6. Percent of incomes \$250+	.972	—	—	—	—	—
7. Percent of incomes \$400+	—	—	—	—	—	—

Education: The High School Attendance Ratio

The index of education chosen for this study is the ratio of high-school enrollment to elementary school enrollment in 1937-38.¹ As was true for other variables, wide intercounty differences are revealed by the distribution of this ratio (Fig. 5).

WHAT OTHER STUDIES HAVE SHOWN

Rural population fertility rates exceeded urban rates in both Europe and North America prior to the twentieth century and in other cultures during the twentieth century.² In the farm population of the United States the highest fertility rates are those in areas with low farm values.³ Occupational differences show the farm owner families to be less fertile than the renter families, and considerably less fertile than farm laborer families.⁴ Low income and isolation (as measured by distance from cities) are associated with high fertility of population in rural areas, although the relation of isolation has not been too definitely established.⁵

For urban areas of the United States, there are indications that differences in fertility due to occupational differences cannot be resolved entirely into differences in economic status.⁶ The inverse relation between economic status and population fertility has been discovered practically to vanish at family rentals above \$40 per month.⁷ It has been found that high social

¹ Data are from biennial reports of the Kentucky State Department of Education. The 1937-38 year was the latest for which the ratio could be determined from published reports.

² Jaffe, A. J. "Urbanization and Fertility," *American Journal of Sociology*, July, 1942, pp. 48-60.

³ Clyde V. Kiser. *Problems of a Changing Population*, *Supra*, p. 144.

⁴ *Ibid.*

⁵ Warren S. Thompson and Nelle E. Jackson. "Fertility in Rural Areas in Relation to Their Distance from Cities, 1930," *Rural Sociology*, June, 1940, pp. 143-162.

⁶ Kiser, *op. cit.*, p. 141.

⁷ Warren S. Thompson, et al. *Average Number of Children per Woman in Butler County, Ohio; 1930: A Study in Differential Fertility*. U. S. Bureau of Census, 1941.

HIGH SCHOOL ATTENDANCE RATIO, 1940



Fig. 5.— High school attendance ratio, 1937-38

status is associated with low population fertility and that this inverse relation holds throughout the entire status range.¹ These latter two statements suggest the influence of social status upon the relation between economic status and fertility of population.²

Net migration during the decade of the twenties from the rural population of the United States was proportionately heavier for white than for colored population. More than three-fourths of the net rural migrants were less than 25 years of age in 1920, and females predominated among the migrants in both the younger and older age-groups. During the three years following the 1930 census, net movement to farms took place, in contrast to net out-migration before and after this depression period in industry. Beginning in 1933, this migration to farms was sharply reduced and once more there was an important movement from farms. Even so, the annual net migration from farms for the period 1930 through 1934 averaged only 120,000 in comparison with an annual average five times as large during the decade preceding 1930. Approximately eight times as many persons as were recorded in the net migration actually moved between farms and non-farm places during the five years from 1930 through 1934.³ Annual net movements cumulate to more than quinquennial net movements, but separation of the net migration into specific age-groups would reveal more significant county net movements.

Swedish population studies reveal contrasts between high rural and low urban fertility. Population increase reached its maximum in Sweden in the decade of the 1870's, due primarily to overseas emigration, but the maximum in natural increase did not occur until the first decade of the twentieth century. After this, a sharp decline in the excess of births over deaths

¹ W. Lloyd Warner and Paul S. Lunt. *The Social Life of a Modern Community*. Vol. 1. Yankee City Series, Yale University Press, New Haven, 1941, p. 252.

² For a discussion of this influence and its significance for research method, see Merton Dale Oyler's "Fertility and Migration of Kentucky Population, 1920 to 1940, as Related to Communication, Income and Education" (Unpublished Ph.D. dissertation, Department of Sociology, University of Chicago, 1943), pp. 6-9, 13, 18-20.

³ C. E. Lively and Conrad Taeuber. *Rural Migration in the United States*. U. S. Government Printing Office, 1939, p. XVI.

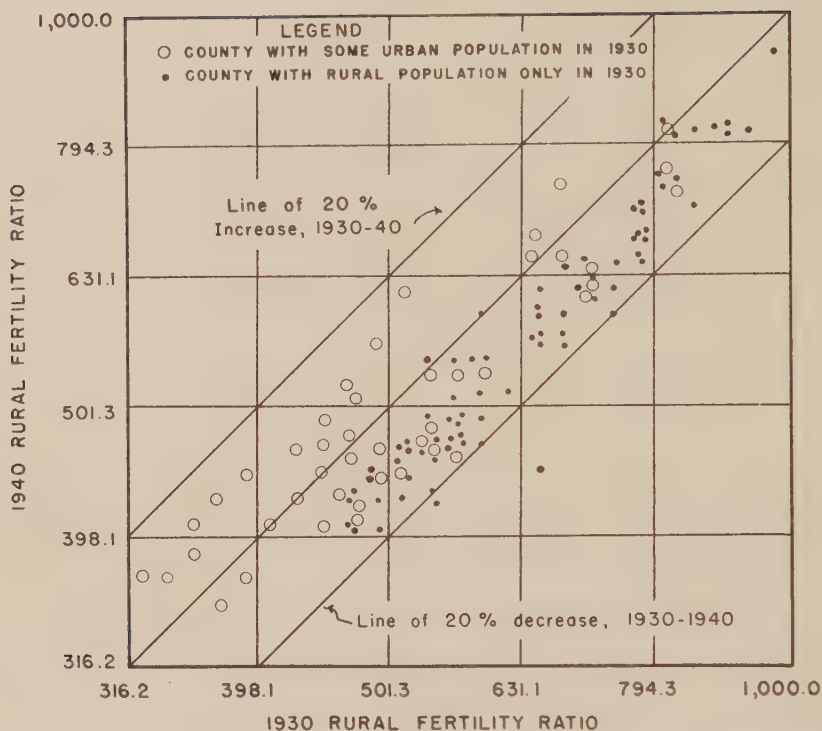


Fig. 6.— Rural fertility ratio of Kentucky counties, 1930 and 1940, standardized for age of women and adjusted for underenumeration of children

set in as a result of the failure of the fall in death rate to keep pace with the falling birth rate. Swedish internal migration has been the dominant factor in determining the growth of urban population, whereas for rural areas a balance between high natural increase and heavy emigration to foreign countries and to Swedish urban areas is the repeated pattern since 1850. Swedish towns present a discontinuous series when classified by size; the rural communities present a remarkably smooth continuum of gradation from purely agricultural to industrial and from small to moderate size.¹

FERTILITY OF KENTUCKY RURAL POPULATION

Decline Between 1930 and 1940

The fertility of the rural population of Kentucky declined in 96 counties between 1930 and 1940, remained approximately the same in 6 counties, and increased in the other 18 (Fig. 6). Among the 24 counties in which popula-

¹ Dorothy S. Thomas. *Social and Economic Aspects of Swedish Population Movements, 1750-1933*. Macmillan Co., New York, 1941.

tion fertility either increased or remained the same, all but three had some urban population in 1930. The presence of urban population operated against decline in fertility in the rural population; the rural fertility ratio dropped in 96 percent of the entirely rural counties, but in only 52 percent of the partly urban counties.

What social change could have occurred in the rural population of the latter counties? The answer here suggested is that it was the migration into suburbs of families with children. Leaving childless couples behind them, these suburban families, by withdrawal from the city, lowered its population fertility (Table 2, page 5). They entered the rural nonfarm population, retarding the decline of, or even increasing its fertility ratio.

Only two counties had a drop of more than 20 percent in the fertility ratio between 1930 and 1940. The most extreme decline was that of Garrard, due to an unusually high ratio (634) in 1930, rather than an unusually low one (454) in 1940. This high 1930 ratio followed a large movement into Garrard county during the 20 years before 1930, from areas of Eastern Kentucky where the population fertility ratios were high.

Population Fertility in Relation to Communication

The tendency for fertility of rural population to decline draws attention to the possibility of relationships between population fertility and the facilities for communication listed in Table 5. During the two decades before 1940,

TABLE 5.—CORRELATION OF THE FARM POPULATION FERTILITY RATIO WITH EACH VARIABLE IN THE COMMUNICATION INDEX (1940), FOR 120 COUNTIES

Variable correlated with fertility ratio ^a	Coefficient of correlation (r)
1. Traffic flow ^a	— .433
2. All-weather road mileage	— .644
3. Farms on all-weather roads	— .769
4. Farm automobiles	— .791
5. Farms electrified ^a	— .555
6. Radio in homes	— .725
7. Magazine circulation ^a	— .595

^a In logarithmic series.

there were rapid changes in the amount of communication available in the counties of Kentucky. The percentage of farms reporting automobiles increased from 10 percent in 1920 to 33.3 percent in 1930 and 35.2 percent in 1940. Farms lighted by electricity¹ increased from 2.2 percent in 1920 to 4.3 percent in 1930 and 16.7 percent in 1940. Farms reporting radios increased from 6.7 percent in 1930 to 49.3 percent in 1940; for all occupied dwellings in the state, radios increased from 18.3 percent in 1930 to 65.3 percent in 1940.

To test the relationship of population fertility and communication, the communication index was correlated with the rural-farm population fertility ratio for all 120 counties ($r = -.777$) and for only the 73 all-rural counties

¹ Electricity was included among the items of communication because it permits more effective use of reading matter and radio reception in the home. County data for railroads were not available. Telephone availability was measured but discarded after extended testing. (See page 36.)

TABLE 6.—CORRELATION OF THE FARM POPULATION FERTILITY RATIO WITH SELECTED PAIRS OF VARIABLES IN THE COMMUNICATION INDEX, 1940

Combinations of variables correlated with fertility ratio	Multiple correlation coefficient (R)
Traffic flow and all-weather road mileage	.643
Traffic flow and farms on all-weather roads	.771
Traffic flow and farm automobiles	.796
All-weather road mileage and farms on all-weather roads	.793
All-weather road mileage and farm automobiles	.798
Farms on all-weather roads and farm automobiles	.791

($r = -.787$). This slight difference is not significant, thus indicating that presence of urban population in the county did not depress the rural-farm fertility, except as it stimulated the development of communication facilities. In other words, communication facilities alone account for 60 percent of the variation in fertility, and the elimination of the partly urban counties from the sample did not increase the correlation significantly.

The farm population fertility ratio was correlated with each of the seven variables in the 1940 communication index, and wide variations were noted (Table 5). The amount of traffic flow is by itself the poorest indicator of the fertility ratio, and farm automobiles (percentage of farms reporting automobiles, 1940) is one of the best indicators.

When pairs of these communication variables are correlated with the farm population fertility ratio, a decided increase is noted in the multiple correlations, as compared with the single relationships of Table 5.

Four different pairs of communication variables have a multiple correlation in excess of .79 to jointly account for variations in the farm population fertility ratio (Table 6).

Geographic Patterns of Fertility in Relation to Cities

One method of measuring the inverse relation of communication and population fertility has been the determination of geographic patterns of population fertility in terms of distance from cities of large size. The index of communication was developed in this study to measure this factor more adequately, but the space patterns of fertility also can be shown readily.

Although Louisville is the only city in the state that exceeded 100,000 population, the metropolitan area of Cincinnati included two Kentucky counties, Campbell and Kenton (Fig. 7). Six counties (two of them are Campbell and Kenton) contained cities of the second size-class (25,000 to 100,000). Six counties contained cities of 10,000 to 25,000 (Campbell county contains one of these cities). Seventeen cities of the fourth size-class (5,000 to 10,000) and 26 cities of the fifth size-class (2,500 to 5,000) were so distributed that all 56 cities were in 47 counties. This left 73 counties of the state entirely rural, with no incorporated place as large as 2,500 in population.

The fertility ratio for the 1940 rural-farm population of each county was divided by an approximate maintenance ratio (360), the result being a net reproduction index.¹ If later estimates of rural death rates in Kentucky for 1940 should require change in this preliminary estimate of 360 for the

¹ See Appendix, page 41, for computation of maintenance ratio. It is merely the fertility ratio that would be required to maintain the population with neither gain nor loss.

POPULATION OF CITIES

- 319,077 Louisville
- 25,000 to 100,000
- 10,000 to 25,000
- 5,000 to 10,000
- 2,500 to 5,000



Fig. 7.—Population of cities in subregions of Kentucky, 1940

RURAL-FARM POPULATION:1940
NET REPRODUCTION INDEX

- 100 - 124
- 125 - 149
- 150 - 174
- 175 - 199
- 200 - 224
- 225 - 249
- 250 - 275

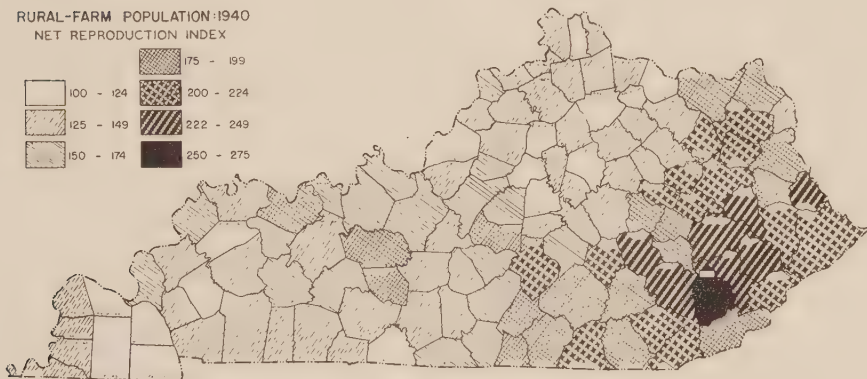


Fig. 8.—Net reproduction index of Kentucky rural-farm population, 1940

rural maintenance ratio, the consequent adjustment would be only slight, and it would not change the comparative positions of the counties (Fig. 8). Reasonable estimates of the range of error would be from 355 to 365.

Comparison of the location of cities, as indicated in Fig. 7, with the area pattern of fertility ratios of rural-farm population reveals the depressing influence of the larger urban centers upon fertility of the rural-farm population. It does not, however, account for the low reproduction index in the southeast part of the Purchase Region.¹ The location of large cities is conspicuously

¹ Migration out of the Purchase Region to Detroit was very pronounced during the early twenties, from reports made by field agents of the Kentucky Agricultural Experiment Station. Large numbers of these migrants returned to the farms of Calloway county and to a lesser degree to the counties adjoining Calloway in the Purchase Region during the depression years of the early thirties. Other suggestions that may explain the low fertility ratio are the location of the State Teachers' College in Calloway county and the attendance of a large number of farm girls at the college during the past few decades. The large magazine circulation in 1940, as indicated by the communication variable 7, may be one effect of this college attendance upon the farm families of Calloway county.

related to the pattern of lowered rural-farm fertility ratios, but the space factor is not so direct in effect as the communication index, or as the income index to be discussed below.

Fertility in Relation to Income

The counties having higher income had lower fertility. This relation was even more pronounced than that of communication and fertility. The relation of fertility and income was significantly higher for the 73 all-rural counties ($r = -.817$) than for all 120 counties ($r = -.774$).

Each component income variable, like the combined index, was inversely related to fertility; and each was about equally strongly correlated with fertility (Table 7).

By multiple correlation, it is indicated that the combination of "income per farm" and "ratio of total to used products" accounted for 55 percent of the variation in fertility (Table 8). Almost identical results attended the combination of "gainful workers per unpaid worker" and "ratio of total to

TABLE 7.—CORRELATION OF THE FARM POPULATION FERTILITY RATIO WITH EACH VARIABLE IN THE INCOME INDEX (1940), FOR 120 COUNTIES

Variable correlated with fertility ratio ^a	Coefficient of correlation (r)	r ²
1. Income per farm ^a	-.709	.503
2. Ratio of total to used products ^a	-.741	.549
3. Income per worker ^a	-.685	.469
4. Gainful workers per unpaid workers ^a	-.659	.434
5. Farms per self-sufficing farm ^a	-.619	.383
6. Percentage of incomes \$250+.....	-.692	.479
7. Percentage of incomes \$400+.....	-.732	.536

^a In logarithmic series.

TABLE 8.—CORRELATION OF THE FARM POPULATION FERTILITY RATIO WITH SELECTED PAIRS OF VARIABLES IN THE INCOME INDEX, 1940

Combinations of variables correlated with fertility ratio	Multiple correlation coefficient (R)	R ²
Income per farm and ratio of total to used products.....	.742	.550
Income per farm and gainful workers per unpaid worker.....	.718	.516
Gainful workers per unpaid worker and ratio of total to used products.....	.741	.550

used products" (Table 8). Thus, the income index accounted for 59.9 percent of the variation in fertility¹, or five percent more than any separate income variable, or any of the three combinations mentioned above in this paragraph.

Amount of rent paid has frequently been used as an index of level of living or well-being. Would it therefore be of use in predicting fertility ratios for a rural population? In a test of this question, the fertility ratio (rural-nonfarm) was correlated with rent,² then with each income index, and

¹ Percent determination is r² or R².

² Average monthly rental value of nonfarm dwellings is reported by counties, U. S. Census, 1940 Housing, First Series, Table 5.

TABLE 9.—CORRELATION OF RURAL NONFARM POPULATION FERTILITY RATIO WITH COMMUNICATION AND INCOME INDEXES AND MONTHLY RENTAL, IN ALL-RURAL COUNTIES^a

Variable correlated with rural nonfarm fertility ratio	Coefficient of correlation (r)
Communication index (1930) ^b	— .632
Income index (1930) ^b	— .688
Communication index (1940)	— .676
Income index (1940)	— .767
Average monthly rental (1940)	— .556

^a 76 counties in 1930; 73 in 1940.

^b See Appendix E for statement on indexes for 1930.

with each communication index for the all-rural counties (Table 9). Correlation of fertility ratio with rent was significant ($-.556$), but was lower than with any of the four income and communication indices. Only one-third (31 percent) of the variation in fertility was associated with variation in rent, whereas over half (59 percent) of the variation in fertility was associated with variation in income ($r = -.767$). It was further established by multiple correlation ($R = .769$) that rent and income together accounted for no more of the variation in fertility than did income alone. It may be concluded, therefore, that rental value is less significant than the other indices in predicting population fertility, but it would be of some use in the absence of the other factors.

Fertility in Relation to Education

High school attendance and specific birth rates.—Because marriage is either postponed until after high school is completed or results in nonattendance if it occurs before then, high school attendance (1937-38) was assumed to have some relation to the rate of births to women 15-19 years of age (1939). The correlation was found to be inverse but low. It may be that the true relationship, although closer than indicated by the correlation coefficient ($r = -.370$) was obscured by the chance fluctuation of small numbers, the uncontrolled influence of communication and income, and the inclusion of urban as well as rural counties.

However, the specific birth rate in 1939 of women aged 25 to 29 was significantly correlated ($r = -.632$) with high school attendance a decade earlier, in 1927-28. This indicates a time lag of not longer than ten years before the cultural changes resulting from high school attendance fully affect the specific birth rate.

High school ratio and fertility ratio.—Other evidence of the relation between (1) education and (2) population fertility was obtained by holding constant the factors of (3) income and (4) communication in partial correlations. Correlation of the high-school ratio with each of the last three of these variables is shown in Table 10. With communication held constant, education was moderately associated inversely with the fertility ratio ($r\ 12.4 = -.244$). With income held constant, education was slightly more associated inversely with fertility ($r\ 12.3 = -.262$). These results, together with those concerning the high school ratio in relation to specific birth rates, now sustain the conclusion that high school attendance, independently of

TABLE 10.—CORRELATIONS OF HIGH SCHOOL RATIO (1937-38) WITH RURAL FARM FERTILITY RATIO, INDEX OF INCOME, AND INDEX OF COMMUNICATION, 73 ALL-RURAL COUNTIES

Variable correlated with high school ratio ^a	Coefficient of correlation (r)
Rural farm fertility ratio, 1940 ^a	.657
Index of income, 1940	.655
Index of communication, 1940	.713

^a In logarithmic series.

income and communication with which it is so closely associated, has a depressing effect on the specific birth rates of age-groups that have attended high school.

NET MIGRATION FROM THE RURAL FARM POPULATION

By Age and Residence, 1930-1940

One of the hypotheses of the study, formulated after a review of previous studies of rural-urban migration, is that out-migration is high between the ages of 20 and 29 years,¹ that it exceeds migration of those in the age-groups immediately younger and older, and that it is partly offset by in-migration beginning at about age 35 and increasing to a maximum between the ages of 40 and 49.

Percent.—In the total population of the state, the two 5-year age-groups from which there was the largest net migration were those between the ages of 10 and 19 in 1930 (or 20-29 in 1940). Each had a net loss of 9.4 percent to areas outside the state (Table 11). These, of course, are the ages in which youths seek jobs. This 10-year interval of maximum net out-migration to other states was flanked by a younger, and by an older 5-year group that lost to interstate migration a net of 5.1 percent in the older and 5.0 percent in the younger group.

Net migration from each specific age of the rural-farm population was similar to that of the total population but the percentage loss was about three times as great. The farm population not only supplied the personnel for net interstate migration in the job-seeking ages, but it also contributed heavily to the rural-nonfarm and the urban net migration stream within the state.

Migration into the rural-nonfarm population in Kentucky from 1930 to 1940 was greatest from the age-group that was 15-19 in 1930 and 25-29 in 1940. It receded gradually, reversing after age 30 into a net out-migration that mounted to 7 percent at ages 45-54. This was followed by a sharp return in the next age-group (55-64) which received the phenomenal net in-migration of 14.8 percent. This is the age of retirement from laboring jobs in cities and from active farm labor.

¹ Ages 20-29 at the end of the decade, or 10-19 at the beginning of the decade. Assuming uniform annual ratio of migration, the modal 10-year age group would be 15-24 at time of out-migration.

TABLE 11.—NET MIGRATION, 1930-1940, BY PLACE OF RESIDENCE
AND BY AGE IN 1930^a

1930 Age-group (years)	Net migration			
	Total population	Rural farm population	Rural nonfarm population ^b	Urban population
Percent of each 1930 age-group				
0 - 4	- 0.9	+ 3.0	- 8.9	+ 0.5
5 - 9	- 5.0	- 7.1	- 8.7	+ 3.7
10 - 14	- 9.4	- 27.9	+ 5.7	+ 16.9
15 - 19	- 9.4	- 31.9	+ 13.4	+ 13.8
20 - 24	- 5.1	- 15.0	+ 5.1	- 0.8
25 - 29	+ 2.8	+ 6.4	+ 3.7	- 1.3
30 - 34	1.4	+ 7.4	- 0.8	- 2.7
35 - 44	- 3.0	+ 0.6	- 4.5	- 5.8
45 - 54	- 7.3	- 4.9	- 7.1	- 10.3
55 - 64	+ 5.4	+ 3.6	+ 14.8	+ 2.3
65 and over	- 1.8	- 3.5	+ 1.6	- 1.7
Total	- 3.6	- 8.3	- 0.1	+ 0.6
Number of people (thousands)				
0 - 4	- 2.9	+ 4.6	- 7.8	+ 0.4
5 - 9	- 15.9	- 11.3	- 7.4	+ 2.7
10 - 14	- 26.4	- 41.3	+ 3.8	+ 11.1
15 - 19	- 24.4	- 41.7	+ 8.0	+ 9.4
20 - 24	- 11.2	- 13.5	+ 2.9	- 0.6
25 - 29	+ 5.3	+ 4.3	+ 1.9	- 0.9
30 - 34	+ 2.4	+ 4.6	- 0.3	- 1.8
35 - 44	- 9.5	+ 0.8	- 3.4	- 6.8
45 - 54	- 18.4	- 5.3	- 3.8	- 9.5
55 - 64	+ 9.2	+ 2.8	+ 5.2	+ 1.4
65 and over	- 2.5	- 2.2	+ 0.5	- 0.8
Total	- 94.2	- 98.3	- 0.5	+ 4.6

^a Minus (—) indicates a net loss by out-migration.

^b Four places (Versailles, Dawson Springs, Carrollton, and Bardstown) changed from rural nonfarm to urban classification between 1930 and 1940. In computing migration, the population of these places has been subtracted from the reported urban population for 1940 and added to the reported rural nonfarm population for 1940 in the respective counties. In the rural nonfarm age-group 25-29 the re-allocation changed the percentage from -2.2 to +3.7. In all other groups the resulting change did not exceed 2 percentage points in algebraic differences.

The urban population received its largest job-seeking group in the younger age-period. The urbanward maximum came from the age-group that was 10-14 in 1930 (20-24 in 1940), and continued at an abated pace in the next group (15-19 in 1930). This was followed by a constantly rising out-migration from the city of all the older age-groups up to 55. The age-group 55-64 (1930) reversed the trend with a 2.3 percent net migration cityward. This is in all probability a retirement of farmers to countyseat towns of more than 2,500 population.

Amount.—When considered in thousands of people, the large net immigration to the rural-nonfarm population (14.8 percent) in the 55-64 age-group included only 5.2 thousand people, much less than the 8 thousand (13.4 percent) job-seeking youth in the 15-19 age-group (Table 11).

The net loss of 98,000 from the total farm population during the decade of the thirties was greater than the state loss of 94,000 to other states, indicating a movement of 4,000 farm people to cities within Kentucky.

The cities of the state received during the decade a net of 23,000 youths (5-19 in 1930). These youths replaced an estimated total of nearly 19,000 older

persons who went to cities outside the state, to rural-nonfarm and to farm residences. Kentucky cities are estimated to have retained a net of 4,600 migrants during the decade.¹

Net Migration from the Cumberland Plateau Subregion

In order to observe in more detail the age differences in net migration, a special analysis of migration to and from the Cumberland Plateau Subregion was made because migration there was in such striking contrast to that in other parts of the state. This area is in the southeastern part of Kentucky along the Virginia border (Fig. 6). It is an agricultural area of rugged landscape with many coal-mining developments during the past thirty years. A large part of the rural-nonfarm population is engaged in the coal-mining industry. By 1940, however, some counties in this subregion had only "worked-out" or abandoned coal areas.

The most recurrent pattern of migration among the three residence classes of this subregion was a combined movement from nonfarm to farm homes of children under 10 in 1930 and adults in the parental age-groups 20-50 in 1930. The number of children moving into the farm population, together with persons 25-34 years of age, suggests that many families returned to their home communities to farm.² The return of persons in the 55-64 age-group of the rural farm population of this subregion, 14 percent (Fig. 9), consisted actually of less than 1.5 thousand people.³ The out-migration of rural-farm youth aged 10-24 in 1930 was matched by some corresponding gains to the urban population. Most of the net-out-migration of farm youth, however, was to places outside the subregion.

Net Migration and the Indexes

The hypothesis that net out-migration of people aged 15-19 is associated directly with population fertility, communication, income, and formal education was studied by correlation procedure. Net out-migration from the 15-19 age-group (1930) in the rural-farm population was correlated (in percentage) with population fertility, income, communication, and education in order to determine the relation of migration severally with each of the other four variables of the counties (Table 12).

It is evident that little direct relation exists between net migration and any of the four summary measures. This is not a result of low migration, be-

¹ The age contrasts in rural-farm and rural-nonfarm population reported above correspond very closely to those reported by Lively and Taeuber in their 1920-1930 figures for the United States.

² It is such an occurrence as this that is concealed when net migration totals for all ages of the farm population together are considered.

³ This contrast is much larger than that in the state population (14.8 percent = 5.2 thousand people). Its presence is reason for notation of a principle which affects migration percentage magnitudes differently for out- and for in-migration. In-migration is added to the 100-percent base as contrasted with the subtraction of out-migration from the base of 100 percent of which it has been a part. Large out-migration can never exceed 100 percent, but large in-migration can. This customary method of expressing migration percentages results in apparently larger percentages for in-migration. The real magnitude would be indicated if the in-migration base were the population at the end of the migration period—in this instance the 1940 population. This distinction becomes important only when large in- and out-migration percentages are used in the same distribution for correlation analysis. This condition did not arise in the migration correlation array next to be described because all 72 counties had net out-migration.

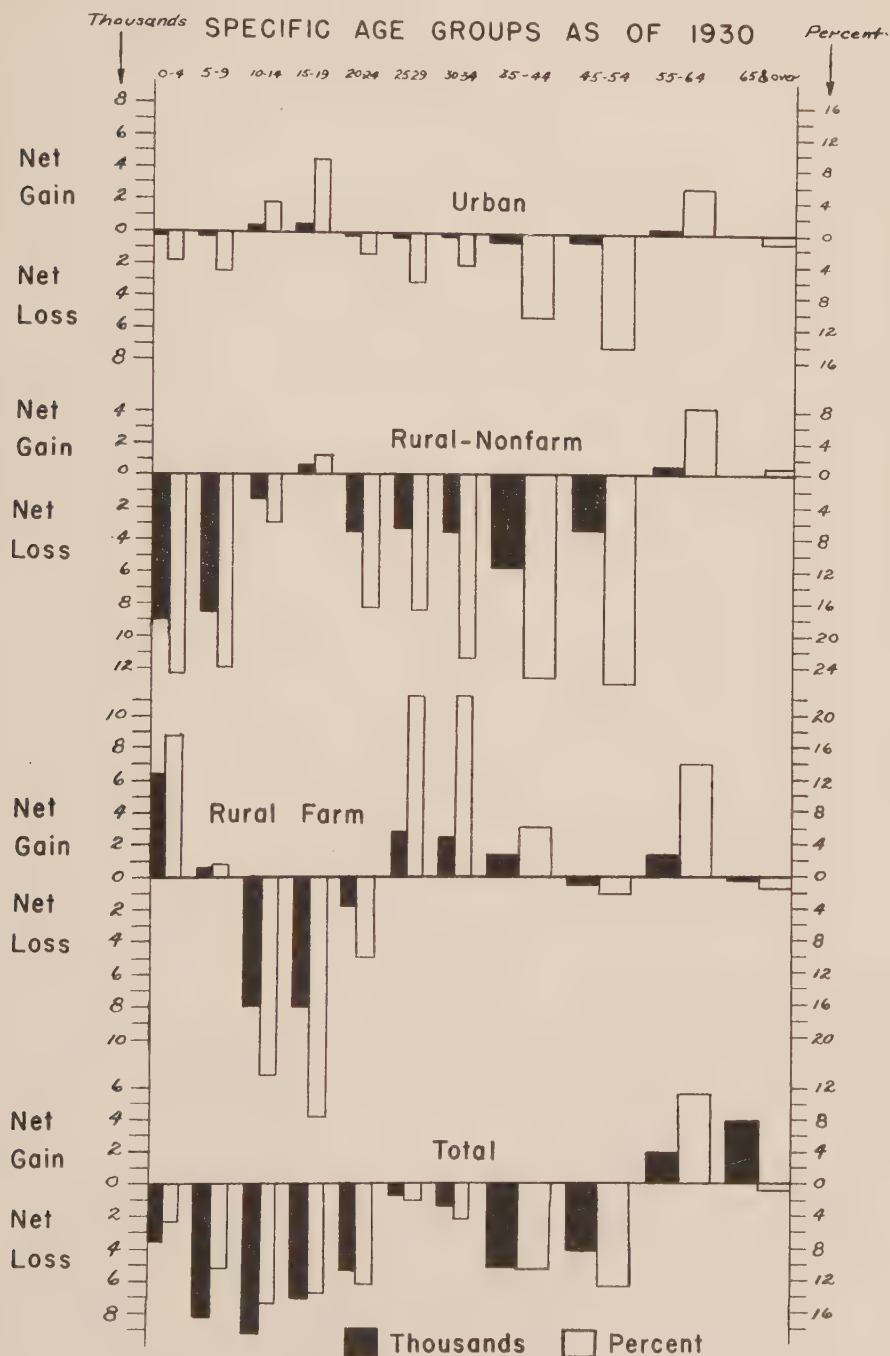


Fig. 9.—Net migration 1930-1940 in Kentucky Social Subregion 9

TABLE 12.—CORRELATION OF NET MIGRATION,^a 1930-1940, FROM POPULATION AGED 15-19 (1930) WITH OTHER VARIABLES^b

Variable correlated with net migration	Coefficient of correlation (r)
Rural farm fertility ratio, 1940 ^c	+ .187
Index of income, 1940	— .279
Index of communication, 1940	— .136
High school ratio, 1937-38 ^c	+ .039

^a Wolfe county was omitted because no high school attendance was reported for the year 1937-38; the correlations are based on 72 all-rural counties.

^b Net out-migration during 1930-40 of the rural-farm population aged 15 to 19 years in 1930, expressed as positive numbers. This eliminates the negative signs for out-migration in Table 1.

^c In logarithmic series.

cause the particular age-group, 15-19 in 1930, had high out-migration. Among 72 all-rural counties, out-migration ranged from 16 to 50 percent and the distribution approximated a normal curve. The scatter diagrams of the correlation pairs showed linearity. The low correlations are thus important in their failure to prove any direct relations.

In further analysis of the association of migration to each other index, partial correlations were computed as follows:

1. Migration
2. Fertility

3. Income
4. Communication

5. Education

$$r_{12.3} = -.070$$

$$r_{13.2} = -.221$$

$$r_{13.4} = -.347$$

$$r_{13.5} = -.333$$

$$r_{15.3} = +.306$$

$$r_{15.2} = +.214$$

$$r_{14.3} = +.240$$

$$r_{14.2} = +.006$$

Migration and fertility.— With income held constant the slight correlation between these factors ($r_{12} = +.187$) disappeared completely ($r_{12.3} = -.070$).

Migration and income.— Low income was associated slightly with migration ($r_{13} = -.279$), but more than any other of the four factors. With population fertility held constant, part of the stimulation of low income to migration was eliminated ($r_{13.2} = -.221$). With communication held constant, however, the association of low income with migration was increased ($r_{13.4} = -.347$). Similarly, with education held constant, the correlation of low income and migration was raised ($r_{13.5} = -.333$).

Migration and communication.— The simple correlation of migration and communication was very low ($r_{14} = -.136$). But when income was held constant, communication was seen to stimulate migration slightly ($r_{14.3} = -.240$). With population fertility held constant, the relation between migration and communication disappeared ($r_{14.2} = .006$).

Migration and education.— The measures of education and migration used in this study were not related ($r_{15} = .039$). But with income held constant, education was observed to stimulate migration more than did any of the other factors ($r_{15.3} = .306$). With population fertility held constant the relation of education to migration was also made apparent ($r_{15.2} = .214$).

Migration, income, education, and population fertility.— Low income and education were about equally related to migration, though in different direc-

tions, ($r_{13.5} = -.333$ is greater than $r_{15.3} = +.306$). Furthermore, when income was held constant and fertility was permitted to vary, the impetus given to migration by education was less evident than when income was permitted to vary and fertility was held constant ($r_{13.2} = -.221$; $r_{15.3} = +.306$).

Summary of influences on migration.—Low income is the strongest single factor, among those here considered, in stimulation of migration. High education is next in influence. High communication is influenced in stimulating migration, but is countered by the accompanying effect of high income. High fertility of population is related so closely to low income that any effect it has on migration is nullified by the operation of other factors; it operated through the stronger factor, low income, with which it is so directly associated.¹

This correlation analysis integrates the separate relationship suggested by Lively and Taeuber² in their summary of net rural migration during 1920 to 1930. They stated that the rural fertility ratio was only slightly related to net rural-out-migration. Per-capita agricultural income and extent of educational facilities also were held to be only slightly related to net out-migration, but in the particular decade under study, out-migration from areas having a low plane of living index was disproportionately greater.

SUMMARY

In Kentucky during the decade 1930-1940 covered by this study the fertility rates for rural population exceeded the urban fertility rates and net migration was cityward. When the differences in population fertility and migration in Kentucky counties during this period were measured in relation to income, communication, and education, the following relations held true:

1. The higher the average farm income, the lower the population fertility rate.
2. The higher the index of communication, the lower the population fertility rate.
3. The inverse relation of income and population fertility is only slightly stronger than the inverse relation of communication and fertility.
4. Income and communication are highly correlated. Public highway construction is shown to result in increased communication somewhat independently of average farm income. This is one way in which acts of public policy affect fertility rates independently of change in private income.
5. Increase in high school attendance in Kentucky counties is the cause of a lower population fertility rate, even when variations due to change in income and communication are removed. This inverse relation between high school attendance and the fertility rate is due at first to fertility decline among

¹ The zero order correlation coefficients treated above are too small for statistical significance. Their designation as positive or negative might be the result of chance. However, by the formula $\frac{\sqrt{1-r^2}}{\sqrt{N-2}}$, the partial correlations of .22 or more could be due to chance

factors only one time in 40; the direction of influence of income, education, and communication are thus established beyond reasonable doubt. Furthermore, they are consistent with commonly held viewpoints about the relationships they represent.

² Supra, pp. 18-19.

the youngest women who delay marriage in order to complete high school training, then later among the older women into which these same women have matured. This statement applies more particularly to isolated agricultural areas than to rural industrial areas.

6. Net out-migration from the farm population reaches a maximum during ages 20 to 24. This represents a modal concentration of the heavy out-migration from all age-groups of the farm youth 10-24 years of age at the beginning of the 1930 to 1940 decade.

7. Low income is the strongest single influence in the stimulation of outward migration of Kentucky farm youth. Amount of education is the second strongest influence on migration.

8. A high degree of communication is influential in stimulating migration when it is operating independently of the counteracting influence of high income (e.g. when increased communication is a result of public improvements rather than of private family expenditures for communication).

9. High fertility of population operates so closely in relation to low income that it seldom has a separate influence toward stimulating migration; rather, it operates through the stronger migration factor, low income, with which it is so directly associated.

CONCLUSIONS AND SUGGESTIONS

Fertility

The aim of Kentucky's only population policy has been to reduce the number of deaths, and the largest gain from this has been a lower infant death rate. There has been no direct effort to influence the birth rate, which has declined from other causes. Decline in the death rate has more than offset the falling birth rate, and there have continued to be many more births than deaths in the farm population of all counties in Kentucky. The greatest natural increase is in areas having the lowest agricultural income and least communication with urban centers. This leads to marked rural-urban contrasts in the comforts and mechanical developments of our machine age. Furthermore, a gradually mounting proportion of the population of the state is being born and reared in the areas where average income is low.

Differences in natural increase, already wide, have been further spread in recent decades by the faster decline of the birth rate in the more urban communities. At the same time, lower infant mortality, following expanded public health programs of maternal and child care, has lifted the natural increase in remote areas as though there had been a rise in the birth rate.

In this study it is shown that high fertility of population, low income, low degrees of communication between areas, and low amounts of formal education together tend to perpetuate low-income areas. An increase in the formal education of people is followed by a decline in the birth rate. The movement to equalize school costs, for example, therefore operated to reduce differences in the birth rates of contrasting communities. There is also an indirect relation between highway construction and decline in population fertility. The more highway traffic passes through a county, the sooner the birth rate declines.

Migration

Extreme differences in natural increase are perpetuated by extreme differences in income among areas of the state. This leads to migration from areas where income is low to areas where it is higher, and from areas where communication is relatively difficult to other areas where there are better facilities for communication. Lack of schools and highways in the low income areas, however, has the opposite effect of retarding migration. This increases the contrasts in real income that are needed to accelerate the flow of the people from low-income areas. The predominant migration from farming communities during the depression of the 30's was of the people who were from 10 to 19 years old in 1930.

Public expenditures for communication facilities have in the past been almost directly in proportion to private expenditures for communication. This is illustrated by the high correlation between all-weather road mileage and ownership of farm automobiles ($r = +.859$). The fact that highway traffic flow is more or less independent of local private automobile ownership is shown by the lower correlation between traffic flow and ownership of farm automobiles ($r = +.582$). Prior to 1930 the ability of counties to pay for highways was the major factor in the location and development of farm-to-market highways and other local road systems not a direct part of the state arterial highway system. After 1930, however, state and federal support was greater than local support of roads.

If more and better roads are built, smaller differences in real income are needed to induce migration. It is not simply the ease of out-migration that is important. It is equally necessary for people who have gone to be able to visit back home and to tell other local people about the ways of life in communities to which they can migrate. It is here proposed, therefore, that when publicly provided communication facilities are developed more fully in areas of retarded economic development, the subsequently increased migration reduces the number of persons to be fed from the limited acres of tillable land.

Because the first to migrate in increasing numbers are the young able-bodied workers, elders in a newly accessible area generally feel that "the good roads are ruining us." They feel, and correctly so in relation to short-time trends, that the number of workers in relation to the number of persons to be supported is tending toward an unfavorable balance. But after the first big increase in out-migration, the returning payments of money from migrant children to their parents increases, and accommodations to the declining labor supply are made. At a later date, probably 20 years later, the proportion of able-bodied workers again approaches a more favorable equilibrium. This cycle of adjustment to the improvement in publicly supported communication facilities has been observed in many formerly isolated counties in Kentucky.

Radio communication, which does not require reading ability, is another communication factor likely to affect out-migration. The sound movie also is slowly coming even to isolated farm communities. As the sound movie is a commercial agency, however, and the areas which can pay the least get the least, it is a communication factor that will reflect differences in income.

It has been proposed that migration-receiving cities cooperate with centers of higher education serving remote communities in producing sound films to help people learn what city life is like, even before leaving home. This method of premigratory education would contribute to occupational and community life adjustment.

Methods in State Administration

One of the first problems encountered in graduated budgetary treatment of counties as a part of state administration is a means of objective determination of degrees of difference in local income-sources of the counties. The income index used in this bulletin is proposed as such an aid, especially for those programs which serve rural areas. The index as constructed, or a modification of it, is a ready tool for a constitutionally acceptable method of graduated treatment of counties.

The index of communication also has uses for administrative controls. The measurement of the degree of achievement in reaching selected goals should be related in part to the facilities at hand in the county.¹ Only after this allowance is made for differences in communication facilities, can the achievements due to the personnel factor be properly evaluated.

¹ Thus, the effectiveness of a public health nursing program in lowering maternal deaths should be related first to the amount of communication facilities available in the county. These facilities help in determining the effectiveness of the educational part of the nursing program and they help in the physical task of servicing the mothers through clinics and office calls.

Appendix A

BIRTH RATES IN RELATION TO AGE OF WOMEN

Women under 20 have not yet reached the age at which the birth rate is highest; women 25 or older have passed that age (Fig. 10). Observation of these differences during the study of high school education and its effect on the birth rate drew attention to a peculiar decline among the older age-groups in certain counties.¹ For example, the curves for Leslie, Wolfe, and McCreary counties each show a decided hump at the ages of 35 to 39. Owsley county, where birth registrations were only 57 percent complete, and the rate was consequently low in all ages, has a similar hump in the curve (Fig. 11). All of these counties are in the Cumberland Plateau subregion of the state. However, the curve of specific birth rates for the whole subregion (Fig. 10) has only a slight hump, and it is similar in shape to the curve for Kentucky.

Owsley, Leslie, and Wolfe counties are nonindustrial counties; McCreary has some coal and timber operations but is mainly an area relying on the low income from noncommercial or subsistence farming. Yet, these are the counties that have the most decided hump in the curve of specific birth rates. Other counties in the Cumberland Plateau have curves more nearly resembling that of the whole subregion.

The birth rate in the nonindustrial counties of this subregion is known to have declined in recent decades. It may be assumed, therefore, that this decline had set in about 15 years before 1939, in the youngest age group of women. By 1939, these women were in their early thirties.

This explanation of the upturn in the curve for these counties accords with the assumption that, in isolated rural areas, the decline in the birth rates of older age-groups follows the decline in younger age groups; a given cohort of women carries the decline to higher age groups as they grow older. In contrast, the women of industrial counties, both rural and urban, are presumed to gradually lower their specific birth rates at all ages simultaneously. The greater cost of rearing children in nonagricultural environments is a partial reason for this contrast.

¹ Births by age of mother for place of residence are reported by counties, U. S. Census, *Vital Statistics of the United States, 1939, Part II*. U. S. Government Printing Office, 1941. The reported 1939 Kentucky births are now found to be 89.2 percent complete in registration for the state as a whole. For the counties included in Figs. 10 and 11, the completeness of registration is found to be: Leslie 91.4 percent, Wolfe 96.6, McCreary 88.6, Owsley 57.1, Letcher 95.0, Pike 82.3, Whitley 76.5 percent. See U. S. Bureau of the Census, *Vital Statistics—Special Reports*, Vol. 17, No. 18. Washington, April 20, 1943. The accuracy of the relative shape of these curves of specific birth rates rests upon the assumption that under-registration is equally spread among the age-groups.

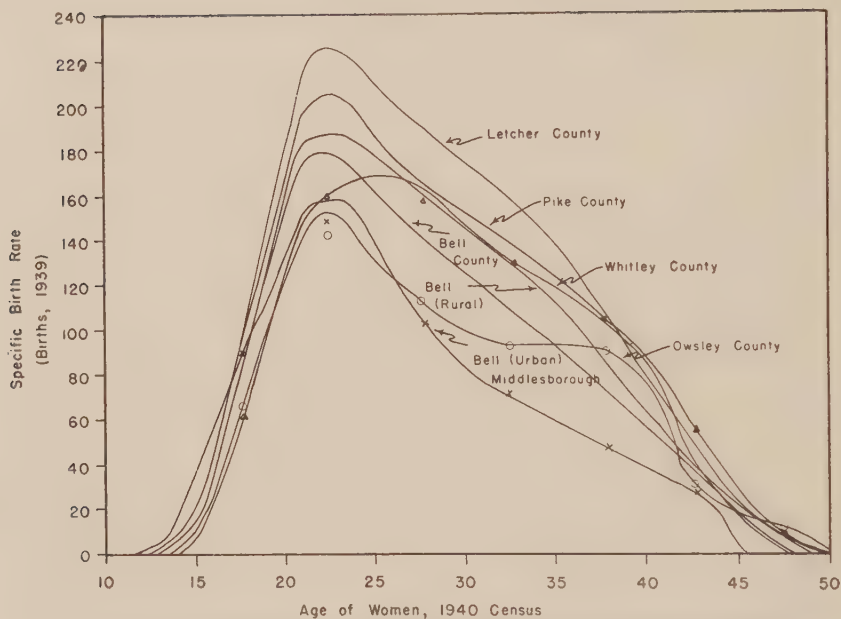


Fig. 10.— Specific birth rate for Kentucky and selected counties

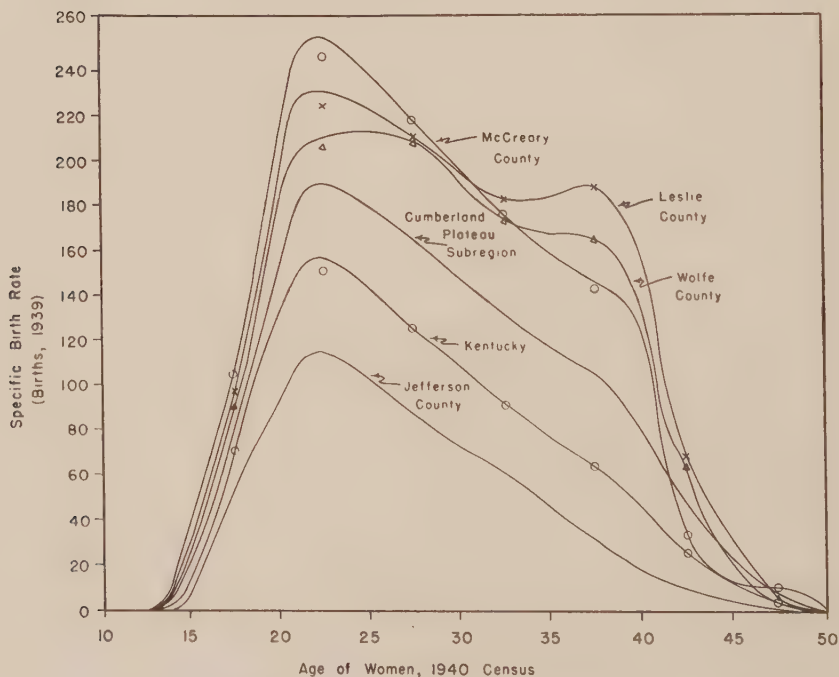


Fig. 11.— Specific birth rate for selected counties of Kentucky

Appendix B

THE FERTILITY RATIO AS A LOGARITHMIC DISTRIBUTION

Since it is known that many biological phenomena¹ are observed in logarithmic series, it is assumed that the fertility ratios used in this study would be similarly skewed, but when the distributions were examined the evidence was not clear. For the 73 all-rural counties, they were skewed slightly to the right; addition of the 47 partly urban counties increased this skewness. Many of the series for the farm and nonfarm populations were similarly distributed.

As in the prior construction of indexes for communication and income, it was desired to remove the skewness of each component distribution. For all of the fertility ratios, it was decided that the logarithmic distributions would be used if at least half of their correlations with other variables were increased thereby. As a test, both logarithmic and arithmetic series were correlated with the indexes of income and communication (Table 13). Of 16 correlations, 10 are seen to have been increased by use of the logarithmic series. This is in agreement with logarithmic expectations. The ratio approaches zero as a lower limit and rises toward an absolute upper limit of a child every year per woman (or 5,000). It is logical to assume then that the numerical change in the fertility ratio is a percentage function of the present level. Thus, a change from 400 to 440 is similar to a change from 800 to 880 as measured in a logarithmic distribution.

¹ For a discussion of these see Schrek, Robert and Lipson, Henry. "Logarithmic Frequency Distributions," *Human Biology*, February, 1941, pp. 1-22.

TABLE 13.—COMPARISON OF ARITHMETIC AND LOGARITHMIC DISTRIBUTIONS OF THE FERTILITY RATIO IN CORRELATIONS WITH INDEXES OF INCOME AND COMMUNICATION, FOR RURAL COUNTIES AND FOR ALL COUNTIES

Index	Rural counties ^a		All 120 counties	
	Arithmetic distribution	Logarithmic distribution	Arithmetic distribution	Logarithmic distribution
Correlations (r) with rural farm fertility ratio				
Income, 1940	— .822	— .817	— .737	— .774
Communication, 1940	— .749	— .787	— .732	— .777
Income, 1930	— .761	— .770	— .861	— .781
Communication, 1930	— .727	— .726	— .673	— .673
Correlations (r) with rural nonfarm fertility ratio				
Income, 1940	— .705	— .767	— .643	— .674
Communication, 1940	— .568	— .676	— .542	— .569
Income, 1930	— .689	— .688	— .634	— .668
Communication, 1930	— .644	— .632	— .524	— .540

^a The entirely rural counties numbered 76 in 1930, 73 in 1940.

Appendix C

METHOD OF CONSTRUCTING THE INDEXES

Each of the variables was so measured that it would have a positive or direct linear relation to every other variable.

For each county, the values of the seven (or eight) variables were totaled and their average was computed. Those arrays of percentages found to be logarithmic distributions were reduced to linear form before they were averaged with the arithmetic arrays for other variables. In a logarithmic series, the logarithm of each percentage was used. Then each logarithm was expressed as a percentage of the highest logarithm in the series (for 120 counties). The result was an arithmetic series of percentages ranging always between 0 and 100 percent. In order to obtain a range approximating the full 100 percent for some of the variables, it was necessary to subtract a constant number (1.0) from each logarithm.

As a practical standard of similarity in the range of the variables, each array of percentages had to range from below 40 percent and up to 100 percent as a maximum. If the highest county percentage in the array was less than 100, then the entire range in percentage had to exceed 60 for incorporation into the index without further modification.

Appendix D

COMMON FACTORS IN THE INCOME AND COMMUNICATION INDEXES

The high degree of correlation ($r = .879$) between the income and the communication indexes suggests the presence of a common factor (Table 14). The correlation of the population fertility ratio with each index is high; with income, $r = -.817$; with communication, $r = -.787$. The difference between the two latter correlations, is not statistically significant, but the income-communication correlation differs significantly from the correlation of each with the fertility ratio. These are indications that the income and communication indexes measure some other common factor more than they measure fertility.

By partial correlation, the independent relation of (A) the 1940 index of income, and (B) the 1940 communication index with (0), the 1940 rural-farm

TABLE 14.—INTERCORRELATION OF THE INDEXES

Indexes that are correlated	Correlations for—	
	Rural counties	All 120 counties
1. 1930 income and 1940 income.....	.957	.955
2. 1930 communication and 1940 communication.....	.904	.799
3. 1930 income and 1930 communication.....	.965	.792
4. 1940 income and 1940 communication.....	.879	.837
5. 1930 income and 1940 communication.....	.898	.870
6. 1940 income and 1930 communication.....	.799	.772

fertility ratio was observed. The coefficients, in comparison with the zero order correlations are:

$$\begin{array}{ll} r_{OA} = -.817 & r_{OA.B} = -.426 \\ r_{OB} = -.787 & r_{OB.A} = -.251 \\ r_{AB} = .879 & \end{array}$$

With communication held constant, the correlation of income and fertility was lowered ($r = -.426$). With income held constant, the correlation of communication and fertility was lowered ($r = -.251$). It was therefore evident that the communication index had within it a factor measured also by the index of income.

To discover this common factor in the two indexes, communication and income, the first step was to find the variable in each index that was most highly correlated with the rural-farm fertility ratio. It was shown previously that each variable in the income index was highly correlated with the rural-farm population fertility ratio. Each of them quite consistently measured a factor common to them all—presumably monetary income. By inspection, one of the two variables correlated most highly with the fertility ratio was selected. "Percentage of farms reporting \$400 or more income," was selected in preference to "ratio of total to used products," in spite of its slightly lower correlation with the fertility ratio, and primarily because it is a more direct expression of monetary income.

In the communication index, "percentage of farms reporting automobiles" was selected because it had the highest correlation with the fertility ratio, higher even than that of the index as a whole. It was found also to be related very closely to the income variable "percentage of incomes \$400+" ($r = .935$).

Partial correlation was used again to measure the independent relation of (1) the communication variable, "farm automobiles," and (2) the income variable "percentage of incomes \$400 +," with (3) the 1940 rural-farm fertility ratio. The coefficients are:

$$\begin{array}{ll} r_{31} = -.791 & r_{31.2} = -.441 \\ r_{32} = -.732 & r_{32.1} = .035 \\ r_{12} = .935 & \end{array}$$

With income held constant, the correlation of farm automobile ownership and the rural-farm fertility ratio was lowered ($r = -.441$). With the automobile ownership held constant, the correlation of "percentage of farms reporting products valued at \$400 and more" and the rural-farm fertility ratio was eliminated ($r = .035$).¹

Using intercorrelations among these variables (Table 15) to reveal the closeness of their association with "ability to buy automobiles," then "Percent of incomes \$250+," "Income per farm," and "Farms per self-sufficing farm," are, in descending order, nearest to "Percentage of incomes \$400+," previously selected to measure the ability to purchase automobiles. But when high correlation with the fertility ratio is taken to indicate the

¹As this latter result is not in harmony with commonly accepted theories of the negative relation between fertility and income, it is considered as a tentative suggestion that partial correlations are of doubtful significance when all of the zero order correlation coefficients are quite high. In this specific use of partial correlation, the one zero order correlation of .935 makes this caution especially pertinent.

TABLE 15.—INCOME CHARACTERISTICS, 1930: MATRIX OF INTERCORRELATIONS

Number and name of characteristic	Number of characteristic						
	8	7	6	5	4	3	2
1. Income per farm	.950	.919	.948	.856	.787	.938	.865
2. Ratio of total to used products ^a	.842	.914	.899	.938	.782	.916	
3. Income per worker	.958	.942	.946	.892	.793		
4. Gainful workers per unpaid worker ^a	.786	.651	.712	.747			
5. Farms per self-sufficing farms ^a	.882	.925	.907				
6. Median farm income	.960	.958					
7. Percentage of incomes \$250+	.968						
8. Percentage of incomes \$400+							

^a Variables 2, 4, and 5 were reversed from negative to positive form after the correlations were computed, by using reciprocals. Hence slight errors (not exceeding .01) may exist in the correlations that include these variables.

common factor, then variables 2, 1, and 7, "Ratio of total to used products," "Income per farm," and, "Percent of incomes \$250+" in descending order, come nearest to the common factor. "Income per farm," ranking second in each test, presumably measures to a high degree the ability of farm families to buy automobiles.

"Percentage of incomes \$250+" is less adequate as an indicator of the fertility ratio, even though it correlates highly (.972) with "Percentage of incomes \$400+." It may well be that "Percentage of incomes \$250+," is a better measure of median than of mean farm income. It probably reflects more exactly the degree of variation in farm family incomes at the lower end of the income distribution in each county. Because it is not sensitive to variations in percentage of incomes above the median, it is a poor measure of ability to own automobiles, and thus a less accurate measure of the rural-farm fertility ratio.

To what extent is "ability to own automobiles" reflected by the variables making up the communication index? The correlation of, "percentage of farms reporting automobiles" with each other communication variable indicates that some of them share very little of the common factor, "ability to own automobiles," and very much of one or more other factors.

Comparison of correlations of "farm automobiles," with each of the other six communication variables in 1940 (Table 3, page 10) reveals a descending rank order as follows: "Farms on all-weather roads," "all-weather road mileage," "radio in homes," "farms electrified," "magazine circulation," and "traffic flow." In correlations of the rural-farm fertility ratio, however, the descending rank order is: "Farm automobiles," "farms on all-weather roads," "radio in homes," "all-weather road mileage," "magazine circulation," "farms electrified," and "traffic flow." Multiple correlations of pairs of these variables with the fertility ratio revealed highest predictive value from a combination of "farm automobiles" and "all-weather road mileage."

The two variables, "all-weather road mileage" and "farms on all-weather roads," are highly correlated ($r = .931$) and both have moderate correlation with the fertility ratio ($r = -.644$ and $r = -.769$, respectively). "Farm automobiles" correlated higher with "farms on all-weather roads" ($r = .921$) than with "all-weather road mileage" ($r = .859$). Therefore, it is reasonable to expect that "all-weather road mileage" is related more to other factors than to "ability to own automobiles." All-weather road mileage is influenced by

state and county highway development and is expected to be less directly related to "the ability to own automobiles."

Similar conditions affect the variable, "average daily traffic flow," which had the lowest correlation both with farm automobiles and with the fertility ratio. The traffic flow variable has least of the factor indicated by automobile ownership, and therefore makes a good combination with it for prediction of the rural-farm fertility ratio.

From this analysis of the factors present in the indexes of income and communication, it was found that their main common factor is "ability to own automobiles." It was found in all of the income variables. Among the communication variables, average daily traffic flow was found to be more closely associated with some factor other than the "ability to own automobiles," responsive to external influences brought to a county by travel not originating locally. It indicates the cultural invasion of an area due to improved highways and increased use of these highways by others than the residents of the county.

Thus, it is concluded that the ability of farm families to buy automobiles is a factor common to both indexes. This factor is reflected with varying completeness by each of the variables in the income index.

INTERRELATIONS OF THE INDEXES

The index of income for 1930 was highly correlated with the 1940 index. The correlation (.957) for the 76 rural counties is only slightly higher than the correlation (.955) for the entire 120 counties. Thus the consistency of the variables used in the index of income is about the same in the 44 urban counties as in the 76 all-rural counties.

The index of communication is less highly correlated between the two census periods and the consistency between urban and rural counties is decidedly lower, although both sets of correlations are highly significant. The correlation of the 1930 with the 1940 index of communication is .904 for the 76 rural counties and .799 for all 120 counties.

The highest correlation of all (.965) is between the 1930 indexes of income and communication for the 76 rural counties, while the correlation for all the 120 counties (.792) is only moderately high. This indicates that for the 44 counties that contain cities the correlation between the two indexes in 1930 was decidedly lower.

Between the 1940 indexes of communication and income the correlation was .879 for the 73 rural counties of 1940 and .837 for all the 120 counties. Thus in 1940 both the rural and the urban counties were intermediate to the extreme contrasts of rural and urban counties in 1930, for correlations of the income and the communication indexes. These correlations are summarized in tabular form in Table 14.

If it is assumed that county changes in income bring about changes in communication, then it would be logical to test the effect of lag in the sequence. Comparison of lines 3 and 5 in the above tabulation reveals the opposite effect for the rural counties, but it does reveal the effect of lag for the 120 counties. The tentative conclusion from this comparison is that there is lag between income changes and communication changes from urban counties, but not for rural counties. Of course the arbitrary span of ten years may be too long to measure this lag most effectively.

It might be assumed that changes in communication bring about changes in income. But comparison of the same column entries in line 4 with those in line 6 reveal no such conclusion for either the rural or the total counties and hence not for the urban counties.

Appendix E

COMMUNICATION AND INCOME INDEXES FOR 1930

In the preparation of indexes of communication and income, it was thought desirable to test separately the appropriateness of data for 1930 and for 1940. Indexes for 1930 were correlated with the other factors used in this study, but only those for 1940 were retained in final analysis; it was concluded that they were more suitable than earlier figures for the purpose of the study.

Communication

Not all the component variables were identically available for 1930 and 1940 indexes. Average daily traffic flow miles were available only from a survey in 1938. All-weather road mileage as a percentage of total mileage was available only for 1940. (In this variable, unimproved and graded dirt roads were combined as not all-weather; federal-state and county mileage was totaled.) The figures used in the index were an average from two reports, 1938 and 1942.

"Percentage of farms on all-weather roads" was used in both the 1930 and 1940 index. Again, improved and unimproved dirt roads were combined as not "all-weather." "Percentage of farms reporting electricity," 1940, was matched with number of families with electricity per 10 families, 1930. "Percentage of total occupied dwelling units reporting radios," 1940, was matched with "Number of families with radios per 10 families," 1930. "Circulation of 12 national magazines in 1937 per 100 occupied dwelling units, 1940," was matched by three other 1930 variables: Number of national farm journals, 1929, per 100 families; circulation of A.B.C. newspapers, 1927, per 100 families; circulation of weekly, semi-weekly, and tri-weekly newspapers, 1928, per 100 families, 1930.

The number of telephones reported by farm families was available from the federal Census of Agriculture, but this variable was discarded after extended testing. Telephones on farms in Kentucky declined from 27 percent in 1920 to 25 percent in 1930, and dropped to 15.8 percent in 1940. It was found that this variable revealed erratic behavior when arranged in a scatter diagram of sigma values as paired with each of the other communication factors. Telephones require the organization of a telephone company in the county, and an increase in the number of them is primarily a problem of the economics of utility organization. After a period of rapid expansion in Kentucky, use of telephones by farm families began to decline before the depression years. There were fewer in use in Kentucky in 1930 than in 1920. The automobile was reducing the emergency use value of the telephone. Moreover, the telephone is a local news carrier rather than an avenue for ideas. The percentage of farms reporting telephones was correlated with the

TABLE 16.—COMMUNICATION CHARACTERISTICS, 1930: INTERCORRELATIONS OF SELECTED PAIRS OF VARIABLES IN COMPARISON WITH IDENTICAL PAIRS FOR 1940

Comparison of selected correlations, 1930 and 1940			Number and name of 1930 characteristic
	1930	1940	
$r_{34} =$	.834	.921	3. Farms on all-weather roads
$r_{36} =$	.744	.765	4. Farm automobiles
$r_{45} =$	.710	.700	5. Farms electrified
$r_{46} =$	.833	.795	6. Radio in homes
$r_{56} =$	.824	.786	8. 36 farm papers
Correlations of other 1930 variables			9. National farm journals
$r_{39} =$	.570	$r_{99} =$.832	10. A. B. C. newspapers
$r_{49} =$	.698	$r_{910} =$.639	11. Weekly to tri-weekly newspapers

fertility ratio but the correlation was only $r = -.617$. The telephone variable therefore is not a good indicator of communication or of the population fertility ratio.

The 1930 correlation of farms on all-weather roads with radios in homes was moderately high ($r = .744$) and the correlation had increased ($r = .765$) in 1940 (Table 16). This increase is not statistically significant (see Appendix G) but is large enough to suggest changing relationships between these variables. Radios in occupied dwellings increased from 18.3 percent in 1930 to 65.3 percent in 1940.

The correlation between farm automobiles and farms electrified was moderate in both years ($r = .710$; $.700$) with no significant change. Meanwhile the percentage of farms in the state reporting automobiles remained quite constant (33.3 in 1930 and 35.2 in 1940) but the farms lighted by electricity changed from 4.3 percent in 1930 to 16.7 percent in 1940. Evidently the increase in number of farms having electricity during the decade was proportional to the percentage of farms reporting automobiles in 1930.

It will be noted that possession of automobiles by farm families was highly correlated (.833) with possession of radios by all families in 1930. The correlation was less (.795) in 1940. Radios are less expensive than automobiles and would not be expected to correlate so highly with income. In 1930 the correlation of percentage of farms reporting automobiles and percentage of farms reporting products valued at \$400 and more was exceptionally high ($r = .935$). As radios become more universally owned it is expected that ownership of radios will become less closely correlated with income.

In 1930 the possession of radios among all families in the county was highly correlated with the percentage of farms electrified ($r = .824$). A decline in this relation occurred during the decade ($r = .786$). The correlation between ownership of radios in 1930 and circulation of national farm journals (1929) was higher ($r = .832$) than its correlation with circulation of A.B.C. newspapers ($r = .639$). The correlation of radio ownership in 1940 and magazine circulation in 1937 was also high ($r = .766$).

The 1930 communication index included only two measures pertaining to

highways and automobiles as compared with four in the 1940 index of communication. However, the 1930 index included four variables pertaining to reading matter as compared with only one in the 1940 index. This relative shift in the use of the two media of communication somewhat parallels the experience of farm families in Kentucky. Automobile ownership increased from 10 percent in 1920, to 33 percent in 1930 and to 35 percent in 1940. With a lag of several years, this increase in farm family ownership of automobiles was paralleled by increased tourist use of automobiles on the highways of the state. Hence, by 1940 the automobile, formerly only a means of local farm to town travel, had become much more significant as an agency of communication with urban and metropolitan centers.

For the 76 Kentucky counties that were entirely rural in 1930 the correlation of the 1930 and 1940 communication indexes was high ($r = .90$); for all 120 counties it was somewhat lower ($r = .80$). This higher correlation for rural counties agrees with the reasonable assumption that changes in amount of communication would be more rapid in counties that contain cities than in rural counties. The stability of the communication index despite change in time and in variables, is attested by these correlations.

Income

Eight characteristics of farm income were selected to develop the index of income. Six of these make use of the one item, "farm products sold, traded or used by farm households," as reported in the Census of Agriculture, 1930 and 1940. The eight variables used to construct the 1930 index of income were:

1. Value of farm products sold, traded, or used per 100 farms, 1929 (logarithm).
2. Ratio of total farm products to value of products used, 1929 (logarithm).
3. Value of farm products per 100 agricultural workers 10 years old and over, 1930 (logarithm).
4. Total gainful workers 10 years old and over engaged in agriculture per unpaid family worker, 1930 (logarithm).
5. Total number of farms per self-sufficing farm, 1929 (logarithm).
6. Median farm product value, 1929 (multiplied by 100) (logarithm).
7. Percentage of farms reporting products valued at \$250 and more, 1929.
8. Percentage of farms reporting products valued at \$400 and more, 1929.

Variables 4 and 5 are quite different from the other variables, in that they make use of nonmonetary data. Variable 4 relates unpaid family workers to total gainful workers in agriculture and Variable 5 relates self-sufficing or noncommercial farms to total farms. The 1940 data were not available for Variable 6, and it is the only one of the 1930 variables not included in the 1940 index. Inspection of the arrays showed that Variables 7 and 8 approached the normal curve, but that the first six variables had highly skewed distributions, until logarithms of their values were used. Approximately linear relations resulted from these adjustments.

1. Value of farm products sold, traded, or used per farm, 1939.—Data are

from the federal Census of Agriculture, 1940, Kentucky, Third Series, County Table XVII, pages 22-23, line 8, value of all farm products sold, traded, or used by farm households, 1939; line 1, all farms, number, 1940. The county value as reported in line 8 was divided by the total number of farms as reported in line 1, to obtain the value per farm. The logarithmic series was used for this variable.

The data for this item in 1929 are from the federal Census of Agriculture, 1930, Volume III, Part 2, Table III, page 524 ft., line 1 number of farms, 1930; line 1, value of all products sold, traded, or used by operator's family, 1929. A comparison of the method of using the data for these items in the two census years is given in the above cited 1940 census report:

Farms Reporting Total Value of Farm Products Sold, Traded, or Used by Farm Households.—For 1939 this represents all farms for which there were usable reports on value of products, but excludes reports for farms showing no products sold, traded, or used by farm households. In other words, the number of farms reporting total value of products, plus the unclassified farms, plus farms reporting no products sold, traded, or used by farm households equals all farms enumerated as of the census date. In 1929 the number of farms reporting for this item includes all farms classified by type regardless of whether or not any farm products were sold, traded, or used by farm households. For example, if a farm reported a complete crop failure, but the kind of crop could be reasonably identified and apparently represented the major crop on that farm, the farm was classified according to the type represented by the crop failure. The 1929 count of farms reporting total value of farm products sold, traded, or used by farm households includes, therefore, some farms which, in the 1939 tabulation, were placed in the category of farms reporting no farm products sold, traded, or used by farm households. (p.5)

2. **Ratio of total farm products to value of products used, 1939.**—The total value of all products is the sum of the value of crops, livestock and live-stock products, sold or traded, forest products sold, and products used by the operator's family (such as meat, milk, poultry, eggs, honey, vegetables, fruits, firewood) but excluded receipts from boarders, lodgers, and campers.

3. **Value of farm products per 100 agricultural workers 14 years old and over, 1940.**—It was found that 99 percent of all persons reported as gainful workers 10 years old and over in 1930 were also 14 years old and over. Therefore, the change in minimum age for the definition of employed workers in 1940 does not significantly affect the comparability of the data for the 1930 and the 1940 dates. This variable, based on agricultural workers rather than farms, avoids the effect of changes from cropper to laborer status and the consequent change in the number of farms as defined by the agricultural census.

4. **Total number of gainful workers 14 years old and over engaged in agriculture per unpaid family worker, 1940.**—This ratio is the reciprocal of the percentage of workers in agriculture who are unpaid family workers.

The change in minimum age from 10 years in 1930 to 14 years in 1940 does not significantly affect the comparability of the data (see discussion of the previous variables).

The logarithmic series was used for this variable.

5. **Total number of farms per farm with major source of income from farm products used by farm household, 1939.**—A change in definition should

be noted. Part-time farms in 1930 were a separate type, sorted out of the whole before self-sufficing farms were classified. The part-time farm classification was not used in 1940. Hence the 1930 variable shows a much higher ratio (a smaller number of farms with major source of farm income from farm products used by farm household) for the suburban counties (Fayette, Jefferson, Kenton, Campbell, and Boyd) if the 1940 method of classification had been used.

6. Median farm product value, 1929.—Data for 1940 are not available from published reports of the 1940 Census of Agriculture.

Data for 1930 were obtained from the Rural Research Unit of the federal Work Projects Administration. The data had been compiled under the direction of A. R. Mangus in his study of rural sub-regions in the United States.

The median farm product value minimizes the influence upon the county total of a relatively few very high incomes. Yet this does not prevent the skewed distribution for the array of counties. The logarithmic series was used for this variable.

7. Percentage of farms reporting products valued at \$250 and more, 1939.—The arithmetic values give approximately a straight line relationship when correlated with each of the first six variables in the income index. This is equally true of the 1930 and the 1940 variable.

This variable measures the percentage of farms that produce a living sufficient to maintain an average family above a relief status or a minimum subsistence level. It measures the extent of freedom from dire want.

8. Percentage of farms reporting products valued at \$400 and more, 1939.—This variable is similar to Variable 7 in that a more nearly normal distribution is obtained with arithmetic values (the complement of the percentage of farms having total products under \$400) than with logarithmic values of these complementary percentages.

This variable measures the percentage of farms that produce a living sufficient to permit the family to operate an automobile without violently disrupting the other budgetary items in the family living, as is demonstrated by the fact that this variable correlates very highly (.935) with percentage of farms reporting automobiles.

Intercorrelations among the eight variables of the 1930 index of income are consistently high (see Table 15).

Appendix F

THE ESTIMATED MAINTENANCE RATIO

The estimated maintenance ratio for rural Kentucky population in 1940 is comparable to the estimate for 1930 (370). The 1940 estimate (360) is based on two types of adjustments of the 1929-1931 Kentucky Life Table. The first type of adjustment is a change in the infant and child death rate, as obtained from a comparison of rates for 1925 to 1929 with rates for 1935 to 1939 in the vital statistics reports of the State Department of Health.

The second type of adjustment is made to transfer the life table entries into cumulative years for ages 0 to 4 (both sexes) and 15 to 44 (females). For this comparison, the number of children under 5 years could not be added as a simple sum of survivors in each of the first five years, because the life table is based on deaths during complete years, and the census enumeration approximates an even distribution throughout the twelve months. To make the appropriate addition, therefore (based on detailed interpolation of neo-natal, infant, and child death rates in 1939), the following percentages were used:

Seventy-eight percent of the first year death rate for children under 1 year;

Total of the first year death rate and one-half the second year death rate for children 1 year of age;

Total of the first two years of deaths and one-half the third year death rate for children two years of age;

Total of the first three years of deaths and one-half the fourth year death rate for children three years of age;

Total of the first four years of deaths and one-half the fifth year death rate for children four years of age.

This method of obtaining the Census equivalent of children under five years of age from the life table yields a directly standardized maintenance ratio.

It reveals the following differences: Life table deaths for the census cohort of children under 10 years of age are found to be 93.88 percent as large as the summation of deaths during ten years of infants and of children 1 to 4 years, or deaths for ten years of all children under 5 years of age (as reported in the life table). If adjustments are made to allow for the fact that slightly over half the deaths of census-enumerated children aged 1-10 occur before the date of the census, then the 93.88 percent becomes 94.25 percent (an average for both sexes). For comparison of survival rates in 1930 with those in 1940, the deaths under 5 years of age for the years 1925-1929 (vital statistics reports, State Department of Health), were compared with those for 1935-1939. Assuming that under-registration of deaths was equal in the two periods, the comparison was made directly on the basis of reported infant and child deaths.

Appendix G

CHARTS FOR ESTIMATING CORRELATION COEFFICIENTS

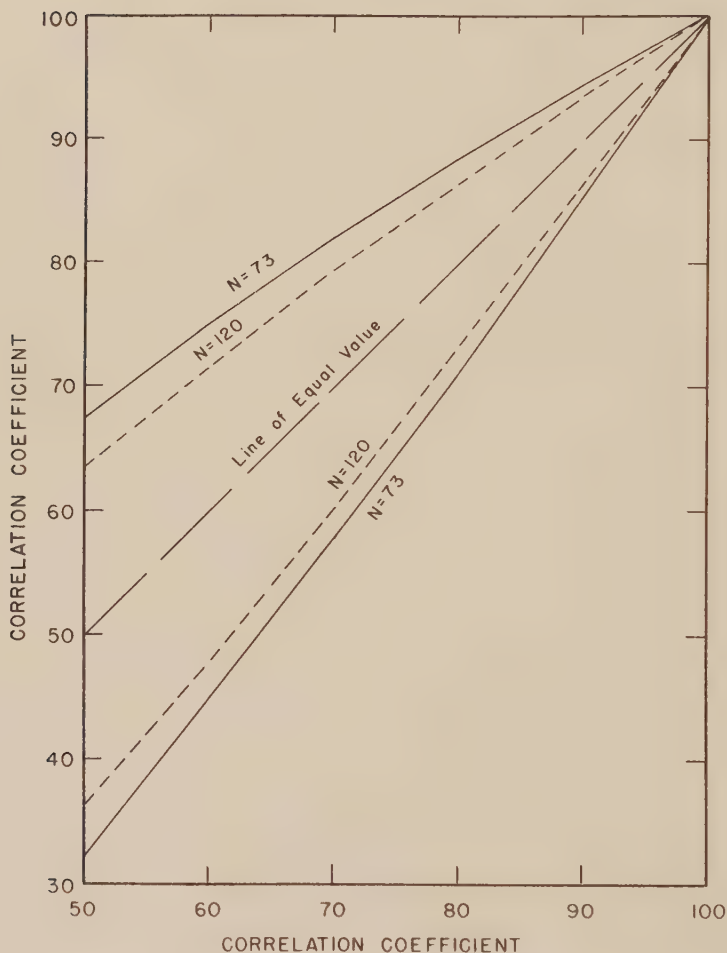


Fig. 12.—Chart for estimating the significance of correlation coefficients

Coefficients of correlation which represent values two standard errors above and two standard errors below correlation coefficients, based on specified numbers of cases. Reference: Fisher, R. A., *Statistical Methods for Research Workers*. London: Oliver and Boyd, 1930. Page 160, ex. 27. The formula used was

$$\text{S.D.} = \frac{1-r^2}{\sqrt{N-1}}$$

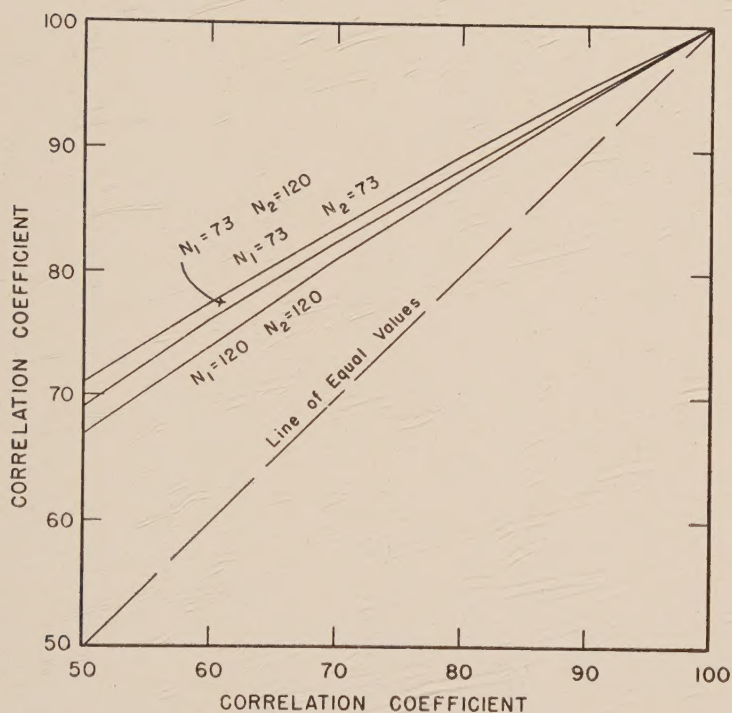


Fig. 13.— Chart for estimating the significance of the difference between two correlation coefficients

Coefficient of correlation required to give a significant difference (as measured by two standard errors) between that correlation coefficient and another, with specified numbers of cases. Reference: Fisher, R. A. *Op. cit.*, page 170, ex. 32.

